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ABSTRACT

The practicum paper describes the development of a mathematics program for primary-level educationally handicapped students, to be implemented by resource room teachers. Developmental areas covered include: numbers (0-10), addition and subtraction (sums to 10), place value, and time and money. The 10-month intervention period was preceded and followed by testing. Intervention emphasized the use of manipulatives (coin and bead sets, counters, attribute blocks, geoboards, interlocking cubes, unit cubes, tens rods) and games in small group settings. Results indicated that: (1) 14 of the 20 students improved their overall scores on an oral instructor-directed test by 20 points; (2) 14 of the students learned to write numerals and count up to 10; (3) nine students learned to solve simple monetary problems; (4) 10 students learned to solve simple subtraction problems; (5) seven students learned to count up to 99; and (6) 11 students learned to recognize the monetary value of various coins. (DB)

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Implementing a Manipulative, Piagetian Mathematics Curriculum for Primary, Educationally Handicapped Pupils

by

James Patrick Burke

Cluster XXVI-A

A Practicum II Report Presented to the Ed.D. Program
in Early and Middle Childhood
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Education

NOVA UNIVERSITY

1989

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Date of Final Approval of Report

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ABSTRACT

Implementing a Manipulative, Piagetian, Mathematics Curriculum for Primary Educationally Handicapped Pupils.
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Descriptors: Arithmetic / Mathematics / Manipulatives / Piaget / Kamii / DeVries / Special Education / Learning Disabilities / Exceptional Children / Perceptual Handicaps / Resource Room Programs / Early Childhood Education

This practicum was designed to enable educationally handicapped pupils to function successfully in the mainstream setting. The primary goal was to establish a functional and reliable mathematics program, employing manipulatives, from which the Special Education elementary level, resource room teachers can emulate. The developmental areas included: Numbers--0 to 10, Sums to 10, Subtraction--sums to 10, Place Value, Time and Money.

The writer began the implementation by administering an oral, instructor-directed test which incorporated areas of the six objectives. The results of the practicum were positive. Analysis of the data for objective A revealed that fourteen of the twenty pupils improved their scores by 20 points. Four of the fourteen pupils surpassed the 20 point minimum score from pretest to posttest. Six pupils failed to achieve the minimum score. All pupils, though, exhibited a gain from pretest to posttest.

Objective B, which requested pupils to write numerals and count elements 0 to 10, was met by fourteen of the twenty pupils. Objective C, related to solving monetary problems, sums to ten, was met by nine of the twenty pupils. Objective D, which called for pupils to solve subtraction problems, was met by ten of the twenty pupils. Objective E, which measured pupil counting ability up to 99 objects, was met by seven of the twenty pupils. Objective F, requiring pupils to tell time at the hour and half-hour, was met by six of the twenty pupils. Objective G, which measured pupil sense of coinage, was met by eleven of the twenty pupils. In each of the above objectives, B through G, there was an individual gain from pretest to posttest.

CHAPTER I

INTRODUCTION

Description of Community

The facility in which the practicum was realized is an urban area located on an island. It is approximately 60 miles southeast of Philadelphia, and 100 miles southwest of New York City. It is the largest of four communities sharing the island. The four smaller communities serve as the city's suburbs. These cities each support their own elementary school system with one exception. Those pupils attend the neighboring school system.

The city's suburbs have no public high school. Their pupils attend the major city's high school as tuition pupils and constitute one-third of the enrollment.

Approximately ten years ago the total population of the city exceeded 47,000. Today, the population is in the vicinity of 40,000 with a projected population of 43,000 in 1990. Traditionally, this writer's city has been known as a summer resort and convention city. It became a casino city when casinos were approved by referendum on November 2, 1976. There are thirteen operating casinos in the city.

The community's twelve public schools consist of eight elementary schools K-6, one elementary school which houses Kindergartens, two junior high schools, grades 7 and 8, and

one senior high school grades 9-12. The community has a school population that exceeds 6,500 and a staff of over 500 teachers and administrators.

A majority of city residents are recipients of Welfare and Aid to Dependent Children (ADC) subsidies, living in high-and low-rise Government sponsored housing projects. The gaming industry is the employment mainstay of the adult majority. Fast food concessions and franchises, liberally stationed throughout the city and boardwalk-beach areas, employ the teen population.

Writer's Work Setting and Role

The school in which the practicum took place is in the South Inlet section of the city. This is the point at which the ocean and bay meet. While this writer operates out of the central Administration Building, it is one of seven schools serviced in his capacity as Learning Disabilities Teacher-Consultant. The writer and his immediate family are products of this area. Thirty years ago it was populated predominantly by those of Jewish and Irish heritage. Today it is vastly Hispanic. These Hispanic families are employed in casino housekeeping and kitchen pantry departments. Bilingual Hispanics are floorpersons, dealers, and restaurant servers. The South Inlet area is experiencing a resurgence phase. Spacious Victorian homes are being razed and newly constructed high-rises and townhouses are catering to the

upper-income families. These condominiums and rentals are purchased as investments and summer domiciles. Thus, the immediate residents are not included in this gentrification.

The pupils in the practicum project school are of low socioeconomic, single-parent stock. The pupil population is 343. Ten years ago the building housed over 900 pupils. The facility, too, has become an urban renewal, gaming casino casualty. Presently, there are 246 pupils of Hispanic ancestry, 81 Black, 15 Caucasian, and 1 Asian. The school building principal is of Hispanic origin. There are 24 teachers; 11 Caucasian, 7 Black, and 6 Hispanic. Three bilingual resource room teachers service the 50 Special Education pupils.

The writer, in his capacity as Learning Disabilities Teacher-Consultant, is responsible for assessing and analyzing pupil learning characteristics. This is accomplished through individual pupil testing. The standardized testing materials measure: reading grade level, mathematics grade level, auditory and visual strengths and weaknesses, and social skills strengths and weaknesses.

The writer further designs instructional strategies and plans educational programs. This is reflected in: the Individual Education Program (IEP) and the teacher implementation conference with resource room teachers, regular classroom teachers, and parents.

Another responsibility of the writer is that of design-

ing and choosing measuring tools in areas of tests and measurements. The children serviced are Child Study Team referrals and reevaluations, Kindergarten through Grade 12. These children include: PreSchool Handicapped, Day Training Eligible, Court Case referrals, and Division of Youth and Family Services referrals.

CHAPTER II

STUDY OF THE PROBLEM

Problem Description

According to the State Special Education Administrative Code (1984), an Educationally Handicapped classification refers to any pupil who has been determined to be eligible for Special Education and/or related services. These pupil participants have been classified and are hereafter referred to as Educationally Handicapped.

Educationally handicapped pupils are not receiving adequate, consistent instruction in order to address deficiencies in mathematics. Pupils are instructed by licensed Special Education teachers in either reading or mathematics. The State of New Jersey Administrative Code states (1984), "Resource room programs shall be instructional centers offering individual and small group instruction in place of regular classroom instruction."

In following the daily lesson plan, elementary level classroom teachers send the mainstreamed educationally handicapped pupils to the resource room for either reading or mathematics instruction. The elementary teachers are responsible for instructing and grading non-classified pupils; Special Education resource room teachers are responsible for instructing and grading classified pupils. Since September 1984, state implementation policy date, educationally handi-

capped pupils' mathematics levels have not exhibited adequate growth; nor have an adequate number of educationally handicapped pupils been declassified. Presently, this writer's school district is serving 1029 Special Education pupils; preschool through grade 12.

The pupils classified as Educationally Handicapped at the beginning of grade one would remain at the readiness level in mathematics for the entire school year. The end of the year test in the mathematics series, if incorporated, would clearly show no growth. When classified pupils entered grade two, their mathematics levels would remain constant until the middle of the school term. At that juncture, educationally handicapped pupils would be at the beginning of the Kindergarten level. Each year, these educationally handicapped pupils would fall further behind their classmates. The writer believes that this academic deficiency can be corrected. The Child Study Team, those who initially classify poor performing pupils, expect a greater percentage of educationally handicapped pupils to re-enter the regular school program after having spent three years in the Special Education setting. A good basic skills foundation achieved through proper training and readiness activities would enable more pupils, those moderately disabled, to exit the Special Education program.

The primary level, educationally handicapped pupils do not have a mathematics curriculum series textbook or workbook

specifically designed to their academic needs. The Special Education teachers have access to the present district mathematics series and are permitted to employ the content of that series; yet, the curriculum is tailored for average to above average pupils.

The thrust of this writer's practicum was that of addressing the need for a concise mathematics curriculum to service the primary level, educationally handicapped pupils. The curriculum should be such that the Special Education teachers can emulate and that it is uniform to service pupils who transfer from school to school within the district. The writer's district has an open enrollment policy due, in part, to accommodate those pupils who frequently relocate in the face of urban renewal and casino projects. Educational time is lost when the curriculum is not uniform.

In light of the above, the Board of Education should provide for textbooks, workbooks, and manipulatives to work in concert with the above mathematics curriculum. Briefly stated, the problem is that the educationally handicapped, elementary level pupils require a mathematics curriculum tailored to their needs; employing manipulatives, oral examinations, and a uniform pace of instruction for each pupil.

Problem Documentation

A problem exists, as can seen by the results of the

Metropolitan Achievement Test, state-wide distribution. These results show that the writer's district, as well as the two largest cities in the state, fall below national and state norms as seen in Table 1.

Table 1

Special Education, Primary Level, Mathematics Averages
Office of School Superintendent, Administration Building

Metropolitan Achievement Test Results

Year	Pretest	Posttest
1984	K.4	K.7
1985	K.3	K.7
1986	K.4	K.6

While there is an average gain of three months per year per pupil, it must be remembered that two-thirds of the practicum population should be functioning two years above Kindergarten level. The pupil participants have the ability to progress more than three months per year as seen in Table 2 on the following page.

The American Association of Mental Deficiency, which changed Deficiency to Retardation, October 1, 1987, indicates that two criteria must be evaluated in making classifications. The AAMR stresses level of intelligence and level of adaptive behavior to be considered.

Table 2

Wechsler Intelligence Scale for Children--Revised, Administered by Child Study Team 1986-1987 school year

No. of Pupils	I.Q. Score
2	86
1	84
2	82
3	80
4	78
2	75
1	74
3	73
2	72

The AAMR classification of mental retardation contains four categories--mild, moderate, severe, and profound--based on levels of intelligence used in conjunction with the classification of adaptive behavior. The classification of mental retardation is appropriate only when an individual falls into the retarded category in both intellectual functioning and adaptive behavior functioning. Intelligence is assessed through objective measurement, whereas adapative behavior can be assessed clinically or by means of an objective scale (Sattler, 1982).

The pupil participants are slightly above the mild level

of mental retardation; although the currciculum will eventually service pupils from the above aforementioned mental retardation categories.

In order to provide documentation of the problem stated in the previous section, the writer solicited the cooperation of the district Special Education, elementary level, resource room teachers. A questionnaire (see Appendix A) was distributed to each teacher. Twenty-five questionnaires were dispensed and twenty-five were returned to the author. This represented a 100% return rate. The results of the entire questionnaire are presented in Appendix B. Yet, a brief discussion of selected questions is examined pertinent to mathematics instruction.

The writer, in authoring the questionnaire, primarily requested the teachers to indicate whether or not he or she consistently employed mathematics activities in a goal-oriented setting, whether or not each teacher followed the Child Study Team's Basic Plan portion of the Individual Education Plan, and whether or not each teacher fully comprehended the necessary components of a primary level, educationally handicapped mathematics curriculum, manipulative-emphasis.

The first ten statements of the questionnaire concerned the evaluation of the present mathematics program, accessible materials and equipment, and teacher practices. In response to the second question concerning the "materials available

for use in the program," 60% of the Special Education teachers stated that much improvement was needed. This leads the author to surmise that the teachers are working with pupils but without a uniform program.

In response to the third statement concerning the "availability of workbooks and other supplementary materials, including manipulatives in the present mathematics program," 56% replied that these were nonexistent, or nearly so. In effect, the teachers are lamenting the fact that the department lacks a suitable mathematics program and that supplementary materials are lacking, thereby detracting the learning handicapped from required visual perceptual technique practice. While manipulatives are available in each building, their correct usage is questioned by the writer. The teachers do require educational direction. This fact surfaced during the several formal and informal conferences the writer had with individuals servicing the Educationally Handicapped. These conferences occurred while the Child Study Team met at various buildings throughout the school year.

While 28% of the teachers were satisfied with their ability to teach mathematics according to the fourth question, 72% admitted improvement was required in honing teacher skills. The time factor, question five, was never an impediment according to the respondents 100% agreement on the satisfactory "availability of time for mathematics instruction." Consolidation and proper planning during the time

factor is of the essence.

The teachers readily admitted to the writer that not only is there an absence of a primary level, educationally handicapped mathematics curriculum but that much improvement is needed in consultation with Special Education staff in adapting a serviceable curriculum: 76% of total respondents contend that some improvement is required when choosing a program which caters to each pupil's needs.

The Special Education resource room teachers are in total agreement that the department requires a mathematics program to service the Educationally Handicapped. In response to the tenth statement that "the present mathematics program addresses visual perceptual deficits of handicapped pupils," 'much improvement' was the verdict by 76%, while 'some improvement' was cited by 16% of the respondents.

While in the process of delivering and collecting each of the twenty-five aforementioned questionnaires, the writer asked each teacher for permission to browse about the resource classroom. The writer's high visibility throughout his years on the Child Study Team served as a buffer if perhaps the teacher felt uncomfortable--which did not seem to be the case in any instance.

The types of manipulative materials claimed to be available to pupils were, with few exceptions, observed to be present in the classroom or available to the teachers in other parts of the school. Most teachers (76%) had some sets

of the following materials: Counting devices, tangrams, rulers, geoboards, and pattern shapes. Less frequently available to the teachers (16%) were construction materials, pan balances, number balances, and colored rods. Only a few classrooms (8%) had play money, numeration blocks, mirror cards, straws or sticks for bundling, manipulative games and/or clocks.

These findings indicate that, although manipulative materials were available in the classrooms, most did not receive frequent use. When manipulatives were used, it was primarily in ways that could be incorporated into a traditional, deductive, skills or fact-oriented curriculum rather than for developing mathematical concepts, for problem-solving, or inquiry, which is a basis for the educationally handicapped mathematics program.

Daily lesson plans, too, frequently submitted to this writer, did not include the use of such manipulatives in mathematics instruction.

The survey certainly provided credible evidence of the writer's pervasive conviction that educationally handicapped pupils are not receiving adequate, consistent instruction in order to address deficiencies in mathematics. It also exhibited that the majority of teachers had poor skills in addressing a pattern of organization for mathematics instruction within the resource room setting. The use of a diagnostic-prescriptive approach in mathematics instruction is,

too, an instructional staff deficiency.

Causative Analysis

The problem of pupil academic deficiencies in not addressing their mathematics delays is due to the fact that the teachers require aid in mathematics activities selection and consolidation of such into computational teaching strategies.

The Special Education teachers operated under the assumption that educationally handicapped pupils would automatically learn to compute when the digits were presented to them. This system may have worked, on a limited basis, through the use of problem context clues and memorization. Yet, the basic skills foundation was weak and unable to support higher processes. The mathematics deficits, left unaddressed, remained; and the pupils lacked the skills necessary for academic growth. These facts were garnered through informal conferences.

A primary cause of the problem was identified in the Individual Educational Plan (IEP). The Special Education resource room teachers have failed to include perceptual techniques and manipulatives to address the needs of educationally handicapped pupils in mathematics remediation.

The IEP is a written instructional plan for a pupil who has been determined eligible for Special Education and related services. It describes the Special Education components and approaches to instruction that must be provided by

the local school district based on the particular needs of the pupil as determined by school personnel, parents and, when appropriate, the pupil.

The IEP consists of two parts; the basic plan and the instructional guide. All areas of the curriculum in which a pupil is to receive Special Education are included in the IEP as well as any necessary modifications in the regular education program. The basic plan portion of the IEP is completed at time of testing by Child Study Team personnel. This portion of the IEP does include remedial/corrective techniques designed for educationally handicapped pupils with mathematics deficiencies.

Each teacher must be knowledgeable in sustaining this program. Required provisions must be made by the teacher to modify the program to best meet each individual need. It is only in this manner that the teacher of the Educationally Handicapped can insure that each pupil will overcome deficits to insure his/her intellectual development.

The IEP is not merely a written document. Once it is developed, it becomes the pupil's program to be implemented by the school district. That is why it is vital that a uniform mathematics curriculum be employed to service the educationally handicapped pupils.

A second major cause of this problem was the lack of definite quality lesson planning. Simply distributing worksheets which haphazardly address a portion of an unnamed

deficit is not establishing a vital resource room program. Each teacher requires aid in the establishment of a conceptual skills program geared for the Educationally Handicapped.

A third cause of the problem related to non-achievement of the Educationally Handicapped lies in teacher inability to choose proper activities; namely texts, workbooks, ditto sheets, and manipulatives. While the writer's district has an abundance of the above teacher aids, the teachers are not skilled as to what deficiencies require attention and by what educational means. A teacher unaware as to what ancillary activities to seize is depriving the pupil of an important opportunity to learn.

A fourth cause of the problem is the time demands faced by the Special Education teachers. Since the state requires the teachers to be responsible for teaching subjects not taught by the regular home base teacher, in addition to addressing special auditory and visual perceptual deficiencies, the resource room teacher feels overwhelmed in subject consolidation. To overcome this frustrated teacher feeling and overcome pupil disability, aid is required by this writer integrating the time frame factor and proper activity consolidation.

A fifth explanation of this area of concern relates to the fact that the mathematics textbooks and corresponding workbooks are purchased by the elected Board of Education. Since the advent of casino gaming, diverse ethnic and educa-

tional representatives have and are seated as board members. While some board members are business persons, none have had experience in the teaching field.

While there is a search committee, whose role is to recommend three different series of mathematics textbooks, the Board of Education has the final say. When this writer informally inquired as to why the Special Education teachers choose not to volunteer for the series search, 84% of these twenty-five teachers stated that each was unfamiliar with either selection of or knowledge of curriculum content. In verbal explanations, 88% of the Special Education teachers claimed a cursory grasp of the present series strengths and weaknesses, yet the same percentage (88%) were neither familiar nor comfortable in choosing a mathematics series.

In addition, many Special Education teachers are unaware of the various areas of academic abnormalities. They require a working model which identifies disability areas, identifies the required activities which address disability area remediation, and consolidation of a successful program from which to emulate.

The Related Literature

Three paramount components arose in the literature review. The first component of the practicum was that of manipulatives. The second component of the practicum issue

was relative to Piagetian developmental stages affecting education and testing procedures. The third replete area was that of mathematics studies pertinent to the Educationally Handicapped.

The developmental theory of Piaget and the similar theories of Bruner and Dienes have intensified research interest in the role of manipulative materials (also called manipulatives) in classroom learning (Leutzinger and Nelson, 1980).

Manipulatives are objects which appeal to several senses and which a pupil is able to touch, handle, and move. In the last three decades numerous studies have probed the whys, whens, hows, and whats of manipulative use. The overriding consensus is that manipulatives can help pupils to understand and use mathematical concepts (Prigge, 1980; Reys, 1981). Generally, what makes learning materials manipulative is that they appeal to several senses and are used by children for physical involvement in an active learning situation. They may be teacher-made or commercially produced; they may be environmental in nature, (money, for example), or derived from mathematical structure, (an abacus, for example, can provide tactile and visual reinforcement of place value) (Derr, 1985).

Although there is no research evidence yet to tell how many stimuli should be presented to students to maximize learning, manipulative teaching aids should include as many

visual, auditory, and tactile clues as possible. The clues should be precise and fairly obvious to the children because small children are easily deceived by distractions.

Kamii (1985) used a Piagetian perspective to build a rationale to explain why group games are good for young children. Three major areas in which group games might foster children's development are discussed. In the socioemotional area, the rationale is that moral development, personality development, and autonomy are enhanced by the social context of peer cooperation which group games necessitate. In the cognitive area, group games are said to contribute to the development of logical thinking by forcing children to come out of their egocentricity and to coordinate different points of view. In the area of motivation, the rationale is that children spontaneously engage in group games so that such games must be naturally motivated and can therefore be powerful classroom tools.

Until they are about seven or eight, for some a year or two later as the educationally handicapped, children are easily swayed by distractions as their minds organize perceptions. In problem solving situations, such factors as background color, the shape of a glass container, or the density of colored dots arranged in a picture for number recognition can distract a young child away from correct problem solutions (Piaget, 1954).

Until they are seven or eight, children cannot hold more

than one idea or variable in mind at any one time. Hence, if an adult changes both the width and the length of a moldable clay cylinder without changing the amount of clay, a young child cannot handle the simultaneous changes of width and length. The child is likely to conclude that the resulting cylinder has either more or less clay in it. Manipulatives aid children to see these relationships (Leon & Pepe, 1983).

During those years before seven or eight--called the "preoperative" stage by Piaget--children find it difficult, if not impossible, to look back at a particular thought process and to be aware of contradictions in logical decisions they have made (Inhelder & Piaget, 1969). In essence, the preoperative child finds it difficult to monitor his own thoughts and to distinguish between what's "out there" (his perceptions) and the order and organization which his mind gives to those perceptions (his abstractions).

In their review of the research on the use of materials in elementary school mathematics, it was noted that in almost half of the studies considered, those who had learned with the help of manipulative materials scored significantly higher on achievement tests than students whose instruction included no use of manipulatives. In almost all of the remaining studies, the two groups were similar in their achievement; there were few instances in which the group not using materials had the higher achievement (Prigge, 1980; Reys, 1981).

There is an inherent subjectivity and novelty in numerical estimation tasks. An estimation task may evoke children's mathematical inventiveness. It is important that teachers not assume that children understand estimation without much practice in counting. Children need to find, for themselves, that mathematics can be fun (May, 1980).

Many children with a basic arithmetic disability are unable to see objects in groups or sets--an ability that enables others to quickly identify the number of objects in a group. Even when adding a group or set of three with a set of four objects, some children with an arithmetic disability must begin by counting the objects one by one to determine the total number in the sets. Manipulatives aid in the counting of concrete objects (Herbert, 1985).

Puzzles of all types are food for problem solving. Primary level children need to work with puzzles that do not have too many parts. Each time a child finds a piece of a puzzle that fits, he has gone through a mental attribute list (May, 1985).

From an analysis of over fifty research studies at the elementary school level, there was a decided difference in the achievement scores of pupils who had used manipulative materials and those who had not. Those who used manipulative materials scored at approximately the eighty-fifth percentile; those not using manipulative materials scored at the fiftieth percentile (Leutzinger & Nelson, 1980). This find-

ing is clearly in agreement with another review. Lessons using manipulative materials have a higher probability of producing greater mathematics achievement than do lessons in which such materials are not used (Prigge, 1980).

In addition to their use in such topics as counting, place value, the basic operations, measurement, and geometry, their usefulness in promoting achievement in problem solving and with fractions has received recent attention. Taylor (1983) found that for the second graders studied, differences in problem solving scores were especially high when manipulative materials were used to introduce content. Using materials for reinforcement also promoted higher scores on a retention test of the content.

The three major parts of the math curriculum in the primary grades are: I--Learning basic facts which require memorization and constant drilling; II--Operation concepts related to addition and subtraction; and, III--Problem solving. This latter skill requires critical thinking development. Children are involved in problem solving anytime they lack the immediate answer (May, 1982).

Piaget (1954) states that it is a mistake to suppose that a child acquires the notion of numbers just from teaching and warns that when adults try to impose mathematical concepts on a child before he is ready, his learning is merely verbal. The development of numerical concepts begins as early as one year with the child's manipulation of one

object after another; this is a prerequisite to counting (Kamii, 1981).

As he plays with form boards, puzzles, boxes, pots and pans, he gains insight into pre-symbolic concepts of size, number, and form. He strings beads or puts pegs into boards and learns about sequence and order; he learns the phrases, 'all gone,' 'no more,' 'too much,' thus adding to his ideas of quantity (Newman & Berger, 1984).

This section of the literature review is relative to Piagetian developmental stages affecting education and testing procedures.

Mathematics may be regarded as a symbolic language whose practical function is to express quantitative and spatial relationships and, whose theoretical function is to facilitate thinking (Hendrickson, 1981; Taylor, 1983). Man, throughout the ages, has developed symbols for expressing ideas in many ways. He talks, reads, writes, composes music, calculates, and engages in other forms of communication. He uses spoken and written language to express many thoughts and feelings, but to express particular types of ideas--ideas of quantity, size, and order--he developed mathematics (Ibarra & Lindvall, 1982).

Developmentalists are convinced that within each young child a process of unfolding occurs to regulate learning in ways that make worksheets and the "force-feeding" of isolated skills inappropriate. Still, worksheets are enormously popu-

lar in early education, and math education assumes that number is learned through internalization (Svenson, 1979).

Why do such antiquated educational practices and assumptions remain popular? Although several factors contribute to neglect of the developmental perspective, early childhood educators can contribute significantly to improving the situation by precisely and scientifically criticizing inadequate educational practices and by advancing scientifically based alternatives. Piagetian theory can aid such efforts because Piagetian research demonstrates a constructivist principle according to which each child builds his or her own knowledge from the inside, through mental activity and in interaction with the environment (Hendrickson, 1981).

Investigations illuminating children's construction of knowledge of language and arithmetic have been made; such studies reveal inadequacies of the common sense approach to education. For example, many children who can write "8" next to a picture of eight ice-cream cones continue to believe that eight chips spread out are more than eight chips pushed close together. From an historical perspective, educators' acceptance of practices based on behaviorism, associationism, and psychometric tests constitutes educational progress. However, such approaches deal with surface phenomena and provide common sense explanations. Piagetian theory goes beyond to encompass behaviorism (Kamii, 1985).

The wealth of literature on mathematical cognition and

on its development covers topics ranging from geometry problem solving to infant perception of numerosity. The writer has limited information accounts of performance on the relatively basic aspects of mathematics that figure prominently in the elementary school curriculum, which is the functional school environment of learning disabled students. These are single-digit addition and subtraction, also known as basic addition and subtraction facts; multicolumn addition and subtraction; and word problems involving these levels of computational skill.

Kamii (1985) describes the sequence of Geneva middle-class school children in a block balancing task. It attempts to pave the way towards understanding the general processes of cognitive behavior. Analysis focuses on the interplay between the child's action sequences and his implicit theories which the observer infers from the sequences rather than from his verbal comments.

Inhelder & Piaget (1969) discuss how one's conception of intelligence and its development profoundly affects the formulation of educational objectives. A mechanistic conception of intelligence leads to the definition of objectives as a collection of fragmented "cognitive skills", while a Piagetian conception attempts to develop children's intelligence as an organized whole.

Kamii (1984) points out adult behaviors likely to help children develop responsibility. Discussion focuses on the

inadvisability of using reward and punishment, the importance of exchanging viewpoints with children and letting them make decisions, and the importance of beginning training for autonomy in the early years.

On the basis of implications drawn from Piagetian theory, an approach to first-grade arithmetic which eliminated instruction and used only two kinds of activities (situations in daily living and group games) was implemented in an experimental context. Situations in daily living and group games, in contrast to "mechanical" worksheet activities, involved logical, "active" thinking were simulated. Children in the experimental group did their arithmetic without pencils by thinking out loud; when given worksheets later as tests they had no difficulty representing their knowledge of sums on paper. Children in the experimental group were also found to be able to memorize sums slightly better by the end of first grade than children in a comparison group who were given traditional instruction with worksheets. To investigate children's ability to understand place value, a technique adapted from Kamii (1983) was devised. Results suggest that, since first graders are still constructing numbers with the operation of plus 1, it is impossible for them to simultaneously build a second level involving higher-order units of 10.

Findings of the above study have been supported in part by other researchers lauding techniques which stress logical,

active, thinking situations (Hendrickson, 1981; Marzola, 1987; & Prigge, 1980). The above do not believe that it is impossible for children to simultaneouly build upon plus 1 foundation. Kamii's critics cite rigidity as a weakness in theory.

The developmental theory advanced by Piaget should be noted when describing the acquisition of arithmetic skills by educationally retarded pupils.

Kamii (1985) discussed a child's progression through a sequence of developmental stages with completion of each stage being a prerequisite for entry into the next. The stages of development are sensori-motor (0-2 years), pre-operational (2-7 years), concrete operational (7-11 years), and formal operations (11-adulthood). Associative learning occurs during the sensori-motor and pre-operational stages with rote learning, concept formation, and problem-solving ability being developed during the concrete stage. Retarded individuals are normally thought to progress through these stages at a speed commensurate with their mental age. Severe and profoundly retarded individuals usually do not exceed the sensori-motor stage, trainable children and adults may reach the pre-operational stage, and educable persons attain the concrete operational stage. The implication is that many retarded persons advance to the concrete operational stage and should be able to think in specific and logical terms. This would allow them to comprehend arithmetical concepts

approaching a fourth-grade level.

Although numerous attempts have been made to accelerate the progress of a child through these developmental stages, research has not produced the desired acceleration (O'Brien, 1983; Torgesen & Dice, 1980).

Ogletree & Chavez (1980) advocate the instruction of finger counting and finger calculation, also known as Chisanbop, as a method of introducing and teaching the basic processes of addition, subtraction, multiplication, and division to children, particularly to those who are mentally and physically handicapped. The sequential process for teaching finger calculations is outlined, with diagrams, as a sequential procedure. Finger calculation is presented as a natural vehicle to learn mathematics for young children because it involves psychomotor activity, sense of touch, visual stimulation, and provides a natural bridge between sensory input and intellectual interpretation. Finger mathematics is seen to provide an environment for effective and efficient learning to take place by having a psychomotor base which is compatible with the learning style of children. It is cautioned that finger calculation is not a panacea or replacement for regular mathematics curriculum and classwork, but should be used as an introductory reinforcement and supplemental technique.

Kamii & DeVries (1978) believe that the learning characteristics of retarded students are not necessarily the direct

result of retardation, but may reflect inappropriate instruction. For example, arithmetic reasoning may be introduced before adequate concrete arithmetical experiences have occurred to develop basic concepts of size, space, and time. Another example would be teaching arithmetic reasoning before the linguistic conceptual level is adequate to comprehend necessary verbal cues.

An emerging focus of elementary and secondary mathematics instruction is on problem solving. This study examined an instructional approach for teaching children with learning disabilities how to solve arithmetic word problems. The study was conducted with 60 fifth and sixth grade students who had previously been identified as learning disabled. The experimental group was taught using an instructional design which involved the teaching of problem solving steps and the use of "prompts" to help students think through the problem. Both the experimental group and the control were permitted the use of calculators. Results indicated that students in the experimental group outperformed the control group. Implications of the study are discussed, stressing that learning disabled students who have exhibited very poor arithmetic word problem solving skills can be taught to be proficient problem solvers. An example of a prompt outline card used with the experimental group is included (Marzola, 1987).

Kamii (1985) cautions against dealing with symbolic

materials, advising teachers to incorporate manipulable objects into curricula. Kamii suggests teachers can encourage children to make predictions about the outcomes of object manipulation and thereby learn essential relationships. The importance of teaching to a child's level of cognitive development is emphasized in an anecdote about the failure of an experimenter to teach children the concept of specific gravity. Kamii maintains this experimental failure was the result of teaching beyond children's capacity for understanding formal operations. Teaching cannot be accomplished directly, asserts Kamii; rather, people can be helped to learn when teachers start with knowledge already available to the learner.

Driscoll (1981) focuses on how the kindergarten and elementary teacher can use Piaget's theory in a practical way, discussing the following four topics: the nature of number, objectives of teaching number, principles of teaching number, and situations in school that the teacher can use to teach number.

Derr (1985) worked with twenty-two 9- to 12-year-old disabled children with severe mathematics disabilities and 18 normal controls with average math achievement were given six tests of conservation. Significant group differences appeared which indicated that many learning disabled children have not yet developed the concept of conservation, even in the upper elementary grades.

Kamii (1985) defines conservation as the ability to deduce, through reason, that the quantity of the collection remains the same when the empirical appearance of the objects is changed. Heavy use of manipulative objects aid in teaching the concept.

Trembley (1980) studied remedial math instruction emphasizing auditory procedures with 224 elementary students with learning disabilities in arithmetic. The results indicated significant improvements in the Standard Aptitude Test for third-grade scores in computation and concepts, fourth- and fifth-grade scores in concepts, and sixth-grade scores in computations. The author supports use of manipulative aids in teaching learning disabled students but cautions in the selection and application of manipulative aids in teaching students who are experiencing difficulty in mastering mathematical concepts.

O'Brien (1983) examined basic counting competencies, difficulties, skill progressions, and variation among 36 moderately retarded and 64 mildly retarded students (ages 5-14). Quantitative and qualitative analyses indicated deficiencies in basic counting competencies and systematic oral- and object-counting errors. Striking individual differences in ability were noted, even within "homogeneous" groups. It was concluded that pupils require many avenues of evaluation, as manipulatives, in raising mathematics grade levels.

Kamii (1986) investigated children's difficulty in

understanding (numerical) place value. A counting and estimating task, based on Piaget's number theory, was devised to determine if children in grades one through five evidenced this construction.

Baroody and Ginsburg (1984) examined the effectiveness of a tutoring program on counting and number skills for trainable mentally retarded (TMR) students (5-14 years old). Experimental pupils received individualized instruction based on counting games while control pupils received instruction on objectives not related to counting. Analysis is presented of pre- and posttests on oral counting, counting transfer, counting by 10, enumeration and production of cardinality rule, finger presentation of 1 to 10, order-irrelevance principle, and equivalence. Pretesting data suggested that basic counting skills cannot be taken for granted in retarded populations. The training was reasonably successful in extending pupils' oral counting sequence, suggesting that short-term intensive individual tutoring that focuses on count patterns is useful, perhaps especially with TMR pupils. Training was not generally successful in producing transfer. Finding suggested that if the pupils' cooperation can be obtained, oral counting training can be effective with mentally retarded children with relatively low mental ages.

Kamii (1985) stresses that the aim of education should be the development of morally and intellectually autonomous

individuals. The opposite of heteronomy, which means being governed by someone else, autonomy means being governed by oneself. Moral autonomy results from the application of "sanctions by reciprocity" in the context of mutual respect between adults and children. Differing from reward and punishment, sanctions by reciprocity provide children with the opportunity to consider other people's points of view and motivate children to construct rules of conduct by coordinating viewpoints with others. As Piaget (1954) believed, when adults use reward and punishment, they reinforce children's natural heteronomy; alternately, adults stimulate the development of autonomy when they exchange points of view with children. As Piaget additionally pointed out, children acquire moral values in the same way they acquire knowledge--by constructing beliefs internally through interaction with the environment. Current educational practice blocks children's development of autonomy in both moral and intellectual realms. Therefore, the time has come to plan a "Copernican revolution" in education, shifting the focus of education from what educators do to children to how children develop (Thornton & Tookey, 1985).

Educators should stimulate children's thinking by bringing different points of view into confrontation, since the exchange of points of view contributes to children's intellectual, social, affective, moral, and political development (Frank, 1979).

In summary, the aforementioned learning characteristics of retarded pupils must be considered when developing instructional strategies for teaching fundamental arithmetic functions and concepts, since a teacher must take into account the readiness level and mental age of pupils when delineating program objectives.

CHAPTER III

ANTICIPATED OUTCOMES AND EVALUATION INSTRUMENTS

Statement of General Goals

It is imperative that educationally handicapped pupils function successfully in the mainstream setting. As a result, the primary goal of this practicum was to establish a functional and reliable mathematics program, employing manipulatives, from which the Special Education elementary level, resource room teachers can emulate. The developmental areas include: Numbers--0 to 10, Sums to 10, Subtraction--Sums to 10, Place Value, Time and Money.

Behavioral Expectations

In light of the aforementioned developmental areas that this practicum sought to address, the following specific behavioral objectives were chosen for this study.

A. Over a period of 10 months, the mathematics grade level of the twenty educationally handicapped pupils will improve by 20 points from pretest to posttest on an oral, instructor-directed test.

B. Over a period of 10 months, twenty educationally handicapped pupils will be able to write numerals and count elements 0 to 10 as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.

C. Over a period of 10 months, twenty educationally handicapped pupils will be able to solve problems that involve the addition of quantities of money, sums to 10 cents, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.

D. Over a period of 10 months, twenty educationally handicapped pupils will be able to solve problems that involve the subtraction of quantities of money, sums to 10 cents, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.

E. Over a period of 10 months, twenty educationally handicapped pupils will be able to count by 2's, 5's, and 10's up to 99 objects and choose the proper standard numeral for the number as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.

F. Over a period of 10 months, twenty educationally handicapped pupils will be able to tell time at the hour, and to the half hour, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.

G. Over a period of 10 months, twenty educationally handicapped pupils will be able to form a collection of pennies, nickels, and dimes that has a given value up to 99 cents as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.

Evaluation Instruments

The first objective, a pre and posttest indicator, was measured by an oral, instructor-directed test (see Appendix C). The remaining six objectives (see Appendix D) were measured by employing oral, instructor-directed, manipulative activities. Since the practicum was designed to address individual deficits, this writer had been cognizant of the following deficiencies. Is the pupil able to finish all problems on the page? Does the pupil frequently lose the place, or encounter difficulty seeing subtraction and reading multi-digit numbers? Does the pupil have trouble hearing the pattern in counting or simply attending to the test? All of the above would suggest a figure-ground disability which would surface, too, in oral reading and problem solving.

During the first and each subsequent objective measurement, this writer was searching for visual discrimination deficiencies by the following observations. Does pupil encounter difficulty in coin differentiation when counting via manipulatives? Is there difficulty differentiating between or writing numbers (3 for 8, 2 for 5)? Can pupil

discriminate between operation symbols? Can pupil discriminate between size of hands on clocks? Digit reversals and lack of regrouping ability would indicate a sequential memory problem.

A spatial perceptual deficiency would be exhibited if the pupil could not readily write on lined paper. Does pupil have difficulty with concept of before/after and noticing size differences in shapes, inability to note equal-sized parts, and aligning numbers? Integrative closure and abstract reasoning skills were monitored during the measurement of all objectives. The writer had been closely searching for pupil inability to visualize groups, missing addends, and missing factors. If pupil is unable to draw conclusions, therefore, trouble will be encountered in noticing and continuing patterns, and counting a pattern from within a sequence. The information contained in the weekly log was evaluated at this juncture, too.

While scores are vital in measuring success or failure, the writer has chosen manipulative activities and oral test items since the test construction was preceded and accompanied by several years' observation of children who were from all socioeconomic and educational strata mentioned by Piagetian theorists.

Math educators articulate their objectives in terms of children's learning of "addition facts" and writing of equations. If children add numerical quantities repeatedly,

actively, in the context of everyday classroom occurrences, games, and problems that they understand, they will remember the results of these mental actions and will become able to read and write conventional mathematical signs.

The focus of the teacher's concern should be on children's thinking rather than on their ability to write correct answers. Children's thinking grows out of their natural intuition and logic, and educators should foster that development rather than seeking to define objectives foreign to that way of thinking (Inhelder & Piaget, 1969).

Another reason for an oral, hands-on approach relates to Piaget's theory of logico-mathematical development. Piaget's theory of logico-mathematical knowledge leads to very different objectives. Since logico-mathematical knowledge consists of relationships made by the child, what is important is what happens in the child's head. By eliminating mindless techniques and arbitrary rules to produce correct, written answers, and by encouraging children to think in their own honest ways, we can turn out students who can think and trust their own thinking. Students who can think have a solid foundation for further learning. Those who can only apply ready-made techniques may get good grades and high test scores for a few years, but they will not have the foundation necessary for higher mathematics (Hendrickson, 1981 & Kamii, 1985).

Furthermore, the social climate and the situation that

the teacher creates are crucial to the development of logico-mathematical knowledge. Since logico-mathematical knowledge is constructed by the child, through reflective abstraction, it is important that the social environment encourage reflective abstraction.

Piaget argued that every child of normal intelligence is able to learn arithmetic. Arithmetic is something children can reinvent and not something that has to be transmitted to them. If children can think, they cannot help but construct number, addition, and subtraction. If math is so difficult for so many children, it is generally because it is imposed too early, and without adequate awareness of how children think and learn (Kamii & DeVries, 1978).

Finally, it is important to encourage children to have their own opinions and to let them decide when another idea is better. Wrong ideas have to be modified by the child. They cannot be eliminated by the teacher. Besides, the nature of logico-mathematical knowledge is such that every teacher can be certain that children will arrive at correct answers, if they argue long enough among themselves (Driscoll, 1981).

This is not to say that children do not learn from workbooks and transmission. They do, and they usually acquire the truth faster by being told than by constructing it themselves. But we must think about learning in a larger context than the memorization of sums and the ability to

produce high test scores. In other words, we need to see autonomy as the ultimate aim of education (Inhelder & Piaget, 1969).

Mechanism for Recording Unexpected Events

In planning a project lasting for an extended time frame, this writer did provide for unexpected occurrences. The author kept a weekly log (see Appendix E) for each of the twenty pupils involved in this project. The log recorded a summary of the strengths and weaknesses which occur daily. These success-failure features were reviewed each week in order to insure that each pupil progressed according to ability level.

This weekly log is now inserted into each pupil participant's folder. The contents of the log have been written in concert with each I.E.P. Therefore, the resource room teacher will have a guide from which to begin mathematics instruction in the Fall of 1989.

CHAPTER IV

SOLUTION STRATEGY

Discussion and Evaluation of Solutions

An educationally handicapped child is unable to learn the way most children learn. For this reason, there is characteristically a discrepancy between the child's learning potential and performance in mathematics. Recent legislation, notably Public Law 94-142 and Public Law 99-457, have spurred growing concern to remedy this situation (Driscoll, 1981; Taylor, 1983).

The problem is compounded when educationally handicapped pupils are mainstreamed or taught in resource rooms along with children having uniquely different learning styles, abilities, and interests. The mathematics teacher must somehow deal with the diverse learning needs of each child. In some instances, the established curriculum goals set by the school district seem unrealistic for certain individuals.

How does one adequately teach the expected content and still help those with legitimate learning difficulties? This review suggests some answers. Its focus is the educationally handicapped pupil, its purpose is to support practical, manageable, and effective ways of helping pupils learn and implement as a basic foundation in mathematics.

For the children in the practicum, difficulty with

numerical relationships begins at an early age. The ability to count, to understand the one-to-one correspondence, to match, to sort, and to compare are dependent upon the child's experiences in manipulating objects. The child with a short attention span, with poor perception, or with poor motor development may not have had appropriate experiences with activities of manipulation--experiences that would prepare him to build understandings of space, form, order, time, distance, and quantity (Kamii & DeVries, 1978). The pupils for whom this curriculum was developed lack optimum motor development opportunities and lack appropriate manipulative experiences.

Ibarra & Lindvall (1982) concluded that first-grade children should have more experience with groups of objects that are separated into two, three, or more parts, with emphasis on the difference between the relationship of part to part and that of part(s) to whole (8 is 2 fours, 5 and 23, and so on). Understanding part-whole relationships is an important prerequisite for learning addition, subtraction, multiplication, and division.

O'Brien (1983), too, concluded from his study that incoming first graders are not as familiar with money as many textbooks and teachers assume they are. As a result, more hands-on experience with money should be available to children in the first grade (Berti & Bombi, 1981).

While the literature review disclosed a plethora of

techniques and mathematics guidelines, none were replete with an appreciable time span study nor more than two measurable objectives. The writer was able to learn colleague techniques--strengths and weaknesses encountered during individual studies, but this only renewed his determination to develop a workable program from which his district could benefit.

Even though this writer is a neophyte in structured study initiation, he is convinced that his general goals should be carried through in his chosen manner. The following studies were useful in the writer's program development.

Manipulatives can and should be used on a regular basis in the mathematics classroom, along with a variety of other tools and methods. A confining, narrow textbook approach to teaching mathematics is inadequate and inappropriate in today's schools. It does motivate students--to take as few mathematics courses as possible--and often does not help them to become independent, confident problem solvers (Herbert, 1985).

Manipulatives allow teachers to create those situations and involve the students actively in the creation of mathematics, resulting in improvements in motivation, involvement, understanding, and achievement--overwhelming reasons to believe that manipulatives are good mathematics (Grossnickle, Foster, Reckzeh, Perry, & Ganoe, 1983).

Some educationally handicapped pupils have fair study skills and are highly motivated. They are willing to learn and try to stay "on task." Typically, this willingness decreases with age as other problems continually frustrate learning attempts. The pupils then begin to misbehave, withdraw, or simply not attend (Reys, 1981).

In regular mathematics classes, attempts to handle the different learning styles through learning center modules are sometimes thwarted. The teacher may be able to spend some time working individually with a child, but overall the setting demands independent work skills. These cannot be assumed. They must be specifically taught and then monitored (Sattler, 1982).

An additional hindrance is the need to use textual materials written for regular class pupils. Most commercial texts are visually confusing. Often, children cannot copy and space out the work as intended. Lessons frequently are not sequenced to provide adequate transition between topics, and there is usually not enough review of important concepts and skills (Young & O'Shea, 1981).

For educationally handicapped pupils who cannot transfer concepts from the concrete to the abstract without teacher assistance, the use of manipulatives may be needed (Leutzinger & Nelson, 1980).

There are ways of circumventing these difficulties so that educationally handicapped pupils can learn in a way that

is appropriate for them. The writer's curriculum will share techniques and ideas for altering the standard mathematics program when necessary to meet individual academic needs.

Description of Selected Solution

The solution to the problem of the primary level, educationally handicapped pupils not acquiring a good mathematics foundation, not having a special needs mathematics curriculum in order to address deficiencies, and not having daily access to manipulatives which strengthen the visual-motor perceptual area, have been described in earlier sections of this paper.

The initial area from which methods and strategies were selected is numbers 0 to 10. Much time had been spent in this area since many of the educationally handicapped exhibit auditory and visual perceptual abnormalities.

This area of the solution was chosen as this writer believes that a lack of integrity of the nervous system is most clearly expressed in the main developmental task during any phase of development. The development of perceptual skills is a child's main developmental task between 3 1/2 and 7 1/2 years of age, when judgement and intellectual development supercede. Clinical case studies show that children with severe perceptual disturbances are often unable to overcome their perceptual handicaps sufficiently by intellectual means to progress satisfactorily in their academic learning;

most notable reading and mathematics.

The second area from which methods and strategies were selected is sums to 10. Continued use of physical objects to aid pupils in understanding addition and in discovering sums of the pairs of larger numbers is essential. The task of memorizing basic addition facts can seem very imposing to a primary level, educationally handicapped pupil.

The third area from which methods and strategies were selected is subtraction--sums to 10. The relationship between addition and subtration should become clear. Now the children begin to note that they do not really have to memorize new facts. They already know the subtraction facts because they know the addition facts.

The fourth area from which methods and strategies were selected is place value. Once again, a new concept is developed in terms of a natural manipulation of physical objects followed by semi-concrete representation of the physical objects. The children, at this juncture, will be able to use the physical objects to demonstrate which of two-digit numbers is greater.

The fifth and sixth areas from which methods and strategies were selected are time and money, taught in concert. Measuring of time and money are two examples of tasks that all children eventually learn to do without ever understanding the very difficult underlying mathematical concepts.

Children learn to tell time and to work with money

because they are immersed in a world in which time and money are very important. Pupils come in contact with these concepts in real situations many times every day.

The Special Services Department of the writer's district recognizes the vital need for an educationally handicapped, primary level, mathematics manipulative activity development program. The Special Education teachers lack a special needs curriculum and require professional aid to incorporate mathematics remediation techniques into the resource room program. The result of this aforementioned malady is that the educationally handicapped pupils are not exhibiting sufficient mathematics growth nor are a sufficient amount of pupils exiting the program after having spent three years with Special Education instructors.

The literature search did not disclose evidence of any program specifically addressing the six mathematics areas mentioned frequently throughout this program. Rather, the literature search simply revealed a number of suggestions which could be employed in addressing the needs of the educationally handicapped through manipulatives. Therefore, the writer proposed to develop a Piagetian, manipulative-emphasized mathematics program from which the Special Education personnel in his district may model their teaching strategies. The writer believes that a workable model will benefit both pupils and staff rather than a singular list of suggested activities.

The solution which had been employed in this practicum involved twenty educationally handicapped, primary level resource room pupils. All pupils are considered to be below grade level in reading and mathematics. All pupils are deficient in basic skills. These class-level designations are based on results of the most recent Metropolitan Achievement Test, administered in the Spring, 1988.

Report of Action Taken

The implementation began with an introductory phase on September 7, 1988. The initial component of the introductory phase was to record the results of an oral, instructor-directed test in mathematics. The purpose of this testing instrument was to obtain a pretest mathematics grade level.

The classroom in which the practicum took place contains five elementary level student tables with teacher cut-out. Each table measures 48" X 96" and can seat four pupils. Each pupil was given a colored polystyrene tray, 19" X 9" X 4 3/8", and a slide-on lid. The trays are stored in a large (48"W X 60"H X 22"D) tote tray cabinet when not in use. Each pupil did receive, prior to the first class date, a Manipulative Aids Kit (coin and bead sets, counters, attribute blocks, geoboard, interlocking cubes, unit cubes, tens rods). Each table, servicing four pupils,

had a balance scale, geometric solids, a clock, several clock faces, and one digital clock.

A second component of the introductory phase was a class explanation and discussion of manipulatives. This was a brief explanation as the pupils had been exposed, during the entire year and on a daily basis, for one period, in manipulative usage.

The final component of the introductory phase of the solution strategy was a teacher-led discussion centering on the importance of mathematics activities. Pupils were graphically shown in this conversation-lecture as to why, for example, they confuse "6" with "g" and "saw" with "was".

Upon completion of the introductory phase of the solution strategy, the mathematics activity phase did commence during the week of September 7, 1988.

Upon the completion of the introductory phase and during the mathematics activity phase implementation, the author was in the process of completing a weekly log. The purpose of the weekly log was to summarize successful and unsuccessful acquisition methods during the week. In addition, the log did afford the opportunity for the author to record any teacher or pupil concerns. A cursory log review did remind the author of activities to be either incorporated or avoided in further skill initiation and reinforcement.

The mathematics curriculum commenced in earnest after the Numbers 0 to 10 pretest. The areas covered during

September and October 1988, included: equivalent sets, zero, pennies, sets of 10, bar graph, and games. Each of the twenty pupils were pre- and posttested relative to the objectives that measured the above areas.

The games were introduced one at a time to each table. Each table (5) seated four pupils. The games are listed at the end of this section.

November 1988, and December 1988, were devoted to teaching the following: sums to 10, addition practice, sum of 10, addition equations, problem solving and games. All pupils had been pre and posttested according to the objectives that measured these areas.

During January and February of 1989, the pupils were taught the following: separating sets, subtracting, subtracting with money, subtraction--sums to 10, subtracting from 10, subtraction equations, skill game, problem solving, counting money, and games. Each of the twenty pupils were pre and posttested relative to the objectives that measured these areas.

During March and April 1989, the pupils were taught place value according to the following areas: recognizing sets of 10, ordering numbers, table form and standard form, order of numbers to 100, comparing numbers, calendar, counting by 10's, counting by 5's and 2's, and games. Each of the twenty pupils had been pre and posttested according to the objectives that measure these areas.

During May and June of 1989, the pupils had been taught the concepts of time and money according to the following areas: telling time--hour, digital clocks, telling time--. half hour, dimes, nickels, and pennies, and games. Pupils were pre and posttested according to the objectives that measured these areas.

At the completion of the ten month implementation, an oral, instructor-directed test in mathematics was administered as a posttest to obtain grade level scores; a twenty point increase was the acceptable norm for each pupil.

The following games were employed during the ten month implementation period:

War

All fifty-two cards are dealt to two players. Without looking at the cards, each player puts his pile face down in front of himself. The two players then simultaneously turn up the top card of their respective piles. The person who turned up the card having the larger number takes both.

If there is a tie, this situation is called "War." Each player in this situation places the next card, face down, on the card that made the tie. Each player then turns over another card from his pile and places it on the one he just put on the first card. The person who turns up the bigger number takes all six cards.

The player who collects more cards than the other at the end is the winner.

When children play War, they judge which of two numbers is the bigger. While judgments can be made perceptually when the numbers are very different (2 versus 9, for example), small differences between two large numbers such as "8" and "9" cannot be judged perceptually.

Go Fish

If there are two players, each is dealt seven cards. If there are three or four players, each receives five cards.

The rest are spread out on the table, face down, and are called the "fish pond." Each player first makes all the pairs he can find in his own hand and puts them down in front of himself, face up. (If he has three that are the same, he can put down only a pair and must keep the third card). The dealer then begins the game by asking someone for a card to make a pair. Each player can keep asking for a card as long as he gets one that enables him to make a pair. Play continues until all the cards have been put down in pairs. The person who makes the most pairs is the winner.

Go Fish contributes to the development of logical thinking in addition to arithmetic. For example, if a person asks for a 5 and does not get one, he is very likely to have a 5. If no one has put down a pair of 5's, the probability of that person's having a 5 is even greater.

Concentration

The instructor selects ten to fifteen pairs of cards that are easily distinguishable (such as those showing dogs, cats, elephants, cars, flowers, and so on). The players arrange them face down in neat rows. They take turns turning up two cards, trying to make pairs. When a player succeeds in making the second card match the first one, he can keep the pair and continue playing. When he fails, he must turn the two cards over so that they are face down again, and the turn passes to the person on his left. The winner is the person who makes more pairs than anybody else.

Concentration can be played with regular playing cards. However, it is better to use cards with pictures on them because it is easier to look for two flowers or monkeys, for example, than to look for two 6's or 7's.

Tic Tac Toe

A piece of heavy cardboard, 12 inches square, is divided by lines into a 3 X 3 matrix. Included with the game are ten plastic pieces, five of which are X's and five are O's. One player uses the X's and the other uses the O's. In turn, each player puts one of his pieces in a space. The object of the game is to get three of one's pieces in a line, vertically, horizontally, or diagonally.

Tic Tac Toe is a game that encourages decentering. Children have to take the opponent's point of view to win, while simultaneously preventing the other person from winning.

Children can, of course, use paper and pencil, or chalk and a chalkboard, to play this game.

Two Addends Up to 4,6(With Dice), and then 10
Double War

Thirty-two cards, eight each from "1" through "4" from two decks, are used. All cards are dealt, face down, so that each player will have two stacks. Without looking at the cards, each player simulataneously turns up the top cards. The person whose total is more takes all four cards. The player who has more cards at the end is the winner.

If there is a tie, each player takes the top card of each of his piles and places it, face down, on the cards that made the tie. Each player then turns over a third card from each of the piles and places it on the ones he just put down. The player whose new total is greater takes all twelve cards.

Double War is a game that presents addends only up to 4. (Another way of getting addends only up to 4 is to use two dice with 1,2,2,3,3, and 4 dots respectively on the six sides.

Concentration with Huckleberry Hound Cards

The players arrange all the cards face down in neat rows. They take turns turning up two cards, trying to make pairs of the same picture. When a player succeeds in making a pair, he can keep it and continue playing. When he fails, he must turn the two cards over so that they are face down again, and the turn passes to the person on his left. The winner can be determined in one of two ways: (1) by deciding who made more pairs than anyone else or (2) by finding out who got the highest total number of points.

Piggy Bank

The players put money in the bank, but they can do this only by depositing 5 cents at a time. All the cards are dealt. Each player puts all his cards in a pile in front of himself, face down. When his turn comes, he turns up the top card of his pile. If it shows either 5 pennies or a nickel, he can put it in his "bank." If it shows any other number, he must discard the card in the middle of the table, face up. The next player who turns up a card that does not show 5 pennies or a nickel looks among the discarded cards trying to find one that gives a total of 5 cents. (If, for example, he is holding a 3 and a 2, he can pick up the 2 and deposit 5 cents in his bank.) The winner is the person who saves the most money.

Piggy Bank involves the set partitioning of 5. For lower-level children it is better to use only the cards with 1 to 4 pennies. The rule of the game can then be simplified

from "find one or two cards that make a total of 5" to "find two cards that make a total of 5." The only possible combinations in this game are 4 + 1 and 3 + 2, but low-level children cannot remember them for a long time.

The cards can be made at home with self-adhesive circles that can be bought at stationery stores, pictures of coins (found in workbooks), or a rubber stamp of a penny that can be ordered through a catalog. The cards can also be made with numerals for use later in the year.

CHAPTER V

RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Results

Objective A was measured by an oral, instructor-directed test which incorporated parts of the remaining six objectives. The complete objective table may be found in Appendix C. The specific objective, "Over a period of 10 months, the mathematics grade level of the twenty educationally handicapped pupils will improve by 20 points on an oral, instructor-directed test," was met by fourteen of the twenty pupils. Four of the fourteen pupils surpassed the 20 point minimum score from pretest to posttest. Six pupils failed to achieve the minimum score. All pupils, though, exhibited a gain from pretest to posttest as seen in Table 3.

Table 3

Objective A Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.38	0.57	+ 0.19

This writer kept all manipulatives handy and directions rather terse; but gave a good deal to time to each pupil,

once directions were understood, to adequately answer each problem.

Learning disabled children, resembling their peers in regular class mathematics, employ concrete thinking skills. The use of simple, familiar objects to illustrate facts, ideas, written symbols, or process does promote understanding and retention. When pupils exhibit auditory memory and visual perceptual deficiencies, an effort should be made to keep verbal directions and explanations short and to the point; visual cue reinforcement is advisable (Pearl, 1982; Slavin, Madden, & Leavey, 1984).

Addition and subtraction emphasizes the gradual acquisition of declarative knowledge facts, changes in procedural knowledge, and the shift from solution of problems by calculational methods to solution by direct retrieval of addition and subtraction facts. These changes in knowledge and processing occur over a period of several years. The rate of change both within and between individuals will vary with the experiential history and learning rate of each person (Carmine & Stein, 1981).

It is certainly possible that the difficulties in mathematics manifested by slow learners is partially attributable to problems with basic facts. Their knowledge of the facts may be weak enough that they cannot be retrieved and must therefore be computed, and the counting procedures for doing such computations may be slow and prone

to error (Algozzine & Korinek, 1985).

Objective B was measured by an oral, instructor-directed, manipulative activity. The complete objective table may be found in Appendix D. The specific objective, "Over a period of 10 months, twenty educationally handicapped pupils will be able to write numerals and count elements 0 to 10 as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity," was met by fourteen of the twenty pupils. Five of the fourteen pupils surpassed the 70% minimum score from pretest to posttest. Six pupils failed to achieve the minimum score. All pupils exhibited a gain from pretest to posttest as seen in Table 4.

Table 4

Objective B Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.36	0.68	+ 0.32

Children with mathematics deficiencies have been observed to have difficulty with activities that require visual perception and visual-motor association (Ysseldyke, 1983). It has been noted that educationally handicaped children seem unable, initially, to count objects in a series. Such children must first learn to count by grasping and

physically manipulating objects. Grasping the objects appears to be an earlier development in the neuromotor and perceptual development hierarchy than pointing to objects (McLeod & Armstrong, 1982). Several children in the mathematics program have exhibited auditory and visual perceptual deficiencies; hence, termed as Educationally Handicapped.

Memory, too, plays a key role in learning. Memory refers to the ability to store information that has been sensed, perceived, and learned. Memory also refers to the ability to retrieve that information from storage when needed (Newman & Berger, 1984). Learning disabled pupils encounter difficulty in memory storage retrieval.

Objective C was measured by an oral, instructor-directed, manipulative activity. The complete objective table may be found in Appendix D. The specific objective, "Over a period of 10 months, twenty educationally handicapped pupils will be able to solve problems that involve the addition of quantities of money, sums to 10 cents, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity," was met by nine of the twenty pupils. Six of the nine pupils surpassed the 70% minimum score from pretest to posttest. Eleven pupils failed to achieve the minimum score. All pupils exhibited a gain from pretest to posttest as seen in Table 5 on the following page. Many children with a basic arithmetic disability are unable to see objects in groups or sets--an

Table 5

Objective C Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.32	0.62	+ 0.30

ability that enables others to quickly identify the number of objects in a group. Even when adding a group or set of three with a set of four objects, some children with an arithmetic disability must begin by counting the objects one by one to determine the total number in the sets (Schunk & Cox, 1986).

The acquisition of expertise in addition has its roots in number knowledge and quantitative understanding. These dual acquisitions are strongly tied to a pupil's counting behavior. A sophisticated counting sequence for digits 1 through 20 is generally acquired prior to Kindergarten. Handicapped children, though, often lack this knowledge (Algozzine & Korinek, 1985; Klahr & Robinson, 1981).

To investigate what children know about value of money and its role in buying and selling, Berti and Bombi (1981) interviewed 80 children from ages 3 to 7. On the basis of the interviews, the authors hypothesized that children's conceptions of value developed through six stages, with the first four related to pre-operational thinking, the fifth and sixth to some use of logical and arithmetical operations.

The first vague awareness that money has something to do with buying and selling, grows into a recognition that one must pay when you buy. In the third stage, a realization develops that other rules, such as certain kinds of money are not the kinds for buying certain things, exists. By the fourth, children realize that sometimes an amount of money is not enough to buy a desired item. During the fifth state a one-to-one correspondence between monetary units and desired purchase is established. Finally, the child begins to use arithmetical knowledge to transform prior intuitions into more precise understandings. It is only at this stage that children are able to make change.

Objective D was measured by an oral, instructor-directed, manipulative activity. The complete objective table may be found in Appendix D. The specific objective, "Over a period of 10 months, twenty educationally handicapped pupils will be able to solve problems that involve the subtraction of quantities of money, sums to 10 cents, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity," was met by ten of the twenty pupils. Four of the ten pupils surpassed the 70% minimum score from pretest to posttest. Ten pupils failed to achieve the minimum score. All pupils exhibited a gain from pretest to posttest as seen in Table 6 on the following page.

Counting exemplifies skill learning in the forefront

Table 6

Objective D Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.26	0.61	+ 0.35

behind the subsequent development of diverse mathematical skills and processes. Counting, estimating, and measuring are three procedures that probably become integrated into a child's body of quantitative knowledge (Piaget, 1954; Prigge, 1980). In learning disabled pupils this integrative process is slow to form, if indeed it does take place (Ashcraft, 1982; Sattler, 1982).

For some children, difficulty with numerical relationships begins at an early age. The ability to count, to understand the one-to-one correspondence, to match, to sort, and to compare are dependent upon the child's experiences in manipulating objects. The child with a short attention span, with poor perception, or with poor motor development may not have had appropriate experiences with activities of manipulation--experiences that would prepare him to build understandings of space, form, order, time, distance, and quantity (Carmine & Stein, 1981; Slaven, Madden, & Leavey, 1984; Yauman, 1980).

Piaget (1954) states that it is a mistake to suppose

that a child acquires the notion of numbers just from teaching and warns that when adults try to impose mathematical concepts on a child before he is ready, his learning is merely verbal. The development of numerical concepts begins as early as one year with the child's manipulation of one object after another; this is a prerequisite to counting.

Objective E was measured by an oral, instructor-directed, manipulative activity. The complete objective table may be found in Appendix D. The specific objective, "Over a period of 10 months, twenty educationally handicapped pupils will be able to count by 2's, 5's, and 10's up to 99 objects and choose the proper standard numeral for the number as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity," was met by seven of the twenty pupils. None of these seven pupils surpassed the 70% minimum score from pretest to posttest. Thirteen pupils failed to achieve the minimum score. All pupils, though, exhibited a gain from pretest to posttest as seen in Table 7 below.

Table 7

Objective E Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.15	0.46	+ 0.31

Concepts of spatial relationships are normally acquired at the preschool level. A child with an arithmetic disability often confuses spatial relationships as: up-down, over-under, top-bottom, high-low, near-far, front-back, and beginning-end. A disturbance in spatial perception further interferes with the visualization of the entire number system (Algozzine & Korinek, 1985; Ysseldyke, 1983).

Rule-based number-comparison training can be effective in promoting retention and transfer with educationally handicapped pupils. Successful learning and transfer appears to depend on firmly establishing prerequisite skills, such as number-after, which may not develop naturally or spontaneously in an educationally handicapped pupil (McLeod & Armstrong, 1982).

Visual perceptual disturbances resulting in confusion of letters (m and n or b and d) usually affect number work as well as reading (3 and 8 or 6 and 9). The inversions, rotations, and distortions should be noted and manipulatives provided to accustom pupils to a visual-haptic technique (Rogers & Saklofske, 1985).

The pupils who had been serviced were classified as Educationally Handicapped; exhibiting auditory and visual learning deficits. All pupils are presently benefitting from the services of a resource room teacher in a mainstream setting. Research on mainstreaming generally finds that learning disabled pupils benefit from regular class placement

if the regular classroom teachers use methods designed to accommodate diverse skills (Pearl, 1982).

Objective F was measured by an oral, instructor-directed, manipulative activity. The complete objective table may be found in Appendix D. The specific objective, "Over a period of 10 months, twenty educationally handicapped pupils will be able to tell time at the hour and the half-hour as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity," was met by six of the twenty pupils. None of these six pupils surpassed the 70% minimum score from pretest to posttest. Fourteen pupils failed to achieve the minimum score. All pupils, though, exhibited a gain from pretest to posttest as seen in Table 8 below.

Table 8

Objective F Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.02	0.40	+ 0.38

Slow learners have great difficulty in the mastery of telling time. Experienced remedial teachers know they often need to settle for less-than-ideal methods to get results with individual disabled learners. Remedial teachers would do well to remember that during this transitional period

there may be more reason than ever to know and be able to use several methods--dependent upon the specific background experience of the pupils. One of the major causes of difficulty in arithmetic arises when the pupil does not thoroughly understand a given process (Perlmutter & Porus, 1983).

The importance of young children's counting skills in the development of mathematical understanding has been well established (Carmine & Stein, 1981; May, 1980; Ysseldyke, 1983). Newman & Berger (1984) investigated how children of different ages, primary grade level, employed counting to make numerical estimates. Regardless of the child's age, greater counting skill is related to accuracy of estimation. In learning disabled pupils, the ability to accurately estimate is flawed (Adelman & Taylor, 1985).

Kamii & DeVries (1978) strongly suggest that there are inner receptive and expressive aspects of mathematical language just as there are with other forms of symbolic behavior. A child first assimilates and integrates nonverbal experiences, then he learns to associate numerical symbols with the experience, and finally expresses ideas of quantity, space, and order by using the language of mathematics. One of the important educational innovations in recent years is the development of new methods for teaching mathematics, with emphasis on meaning rather than on rote learning. This emphasis on meaning is most difficult for an educationally

handicapped pupil. Once mastered, though, the pupil can proceed to higher processes (Ashcraft, 1982).

Objective G was measured by an oral, instructor-directed, manipulative activity. The complete objective table may be found in Appendix D. The specific objective, "Over a period of 10 months, twenty educationally handicapped pupils will be able to form a collection of pennies, nickels, and dimes that has a given value up to 99 cents as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity," was met by eleven of the twenty pupils. Three of the eleven pupils surpassed the 70% minimum score from pretest to posttest. Nine pupils failed to achieve the minimum score. All pupils exhibited a gain from pretest to posttest as seen in Table 9.

Table 9

Objective G Pre and Posttest Mean Results

Pretest Mean	Posttest Mean	Gain (+) or Loss (-)
0.16	0.51	+ 0.35

A child's initial concept of quantity is evidenced in his early language in such expressions as: "all gone," "more", "big," and "little." If children are deprived of playing with household articles such as pots and pans, they become slow in perceiving a sense of space, sequence, and order.

Early engagement in blocks, puzzles, models, or construction-type toys is essential (McLeod & Armstrong, 1982).

Monetary systems are certainly more complicated than decimal counting systems; which groups only by tens. In the United States, the grouping jumps by twos, tens, and even by fives and fours. Coin sizes, too, are not proportional to their value. It is most difficult convincing pupils that a dime is worth more than a nickel. Authors state that beginning instruction should be with real coins (O'Brien, 1983; Prigge, 1980).

In planning valuable and effective activities with learning disabled pupils, Grossnickle, Foster, Reckzeh, Perry, & Ganoe (1983) advocate use of real coins, isolate money instruction from other mathematical skills and concepts, and be aware of any perceptual, language, or integrative processing deficits. Trained instruction must be able to approximately accommodate pupils.

Findings of the above studies have been largely supported by a number of other studies that have employed essentially the same approach.

Kamii (1983) asserts that number could not be solely derived from iteration. As a result, counting might have little to no operational value; until operativity is achieved, the mechanism of numerical thinking is not effective. This is even more evident in the academically handicapped. Well-structured and consistent training in

counting may be the foundation for mature number concepts. This is indeed in alignment with Piagetian theory (Kamii & DeVries, 1978).

As time progresses, children realize that certain problems have solutions, precise and specific, in regard to measurement operation. In a typical Piagetian task of conservation of length, the functional use of counting-based measurement is employed. Children begin to readily see the distance traveled over a zigzag path of match sticks compared to the distance traveled over the same number of sticks arrayed in a straight path. These paths are broken up into subunits that can then be counted. This is in contrast to the educationally handicapped pupil who relies on the perceptually misleading cues of the endpoints (Kamii, 1985).

Regardless of the employed procedures, teaching mathematics skills of a fundamental and practical nature to educationally handicapped pupils requires a sequential, concrete, and highly structured approach. Instructional strategies should be aimed at pupil mental age rather than chronological age. The specific approach employed must incorporate several modalities; visual, auditory, tactile, and kinesthetic. Flexible instruction prohibits hesitancy in alternate strategy choice. Practicality, too, must be considered in determining concepts to be taught.

Conclusions

This writer is confident that a small group of five pupils would benefit from this manipulative emphasized mathematics curriculum. The resource room teacher is required to constantly survey each learning style; which was found to be unique in each of the twenty pupil participants. The degree of auditory and visual perceptual deficiencies did vary and the pace had to be adjusted for each pupil. A small group is essential for optimum learning. The entire thrust of this practicum was to identify individual learning assets and liabilities. To mass produce this curriculum was not the aim of this writer. It is tailored to service not more than five pupils at a given time.

The resource room teacher must work from the basic plan and the instructional guide as well as assess strengths and weaknesses enumerated in the Weekly Log. A group larger than five would not properly service each educationally handicapped pupil. When a solid conceptual skills foundation is realized then pupils can move ahead and the possibility of declassification becomes a reality.

Recommendations

The writer has three specific recommendations based upon the results of this practicum. First, that the Special Education, primary level, resource room teachers incorporate this manipulative working model, which addresses visual-motor

perceptual deficits, into their instructional program.

Second, that the Special Education, primary level, resource room teachers include mathematical goals which address perceptual deficiencies in their Instructional Guide (teachers' portion of IEP). Three, that the Special Education, primary level, resource room teachers employ the work sheets which are in the custody of the media specialists in each building. This should be a pencil and paper and oral exercise in concert with the above mentioned program.

The writer believes that perceptual deficits will be addressed if the teachers follow the above recommendations. Pupils will be employing auditory, visual, and haptic (touch, sensation) modalities, thus changing liabilities into assets.

Dissemination

The results of this practicum project were shared via three avenues. Initially, practicum results were submitted to the Superintendent of Schools, who made it available to the Assistant-Superintendent of Special Services, who oversees Special Education teachers. The writer is available to aid those teachers who will adopt his program.

Secondly, the writer submitted a copy of this practicum to the Special Education teachers in the school in which the practicum took root and grew. It will be placed in the teachers' room book case.

Finally, the writer submitted a copy to the Association

of Learning Consultants in his state, of which he is an active member.

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APPENDIX A

TEACHER QUESTIONNAIRE

Evaluation of Program, Materials, Equipment, and Practices

DIRECTIONS: Evaluate your mathematics program on each item listed by circling the appropriate number on the four-point rating scale.

USE THE FOLLOWING RATINGS:
1-I am satisfied with this
2-This needs some improvement
3-This needs much improvement
4-This is nonexistent, or nearly so

1. Pattern of organizing within the classroom for mathematics instruction	1	2	3	4
2. Materials available for use in the program	1	2	3	4
3. Workbooks and other supplementary materials available; as manipulatives	1	2	3	4
4. Teacher knowledge of how to teach mathematics effectively	1	2	3	4
5. Time available for mathematics instruction	1	2	3	4
6. Extent to which pupils enjoy mathematics	1	2	3	4
7. Extent to which staff has input on program choice	1	2	3	4
8. Extent to which program is related to specific needs of all the individuals within program	1	2	3	4
9. Extent to which you are familiar with goals of program	1	2	3	4
10. The present mathematics program addresses visual perceptual deficits of handicapped pupils.	1	2	3	4

DIRECTIONS: Selected responsibilities of the Special Education teacher are listed below. Indicate by circling the appropriate number the extent to which you reflect each characteristic or meet each responsibility.

Use the following ratings:

1-Almost always
2-Most of the time
3-Sometimes
4-Seldom or never
5-Undecided

As a Special Education teacher, I

1. Aim mathematics instruction toward achievement of specific goals.	1	2	3	4	5
2. Adapt mathematics instruction to the individual levels, abilities, and needs of all pupils.	1	2	3	4	5
3. Use diagnostic-prescriptive approach in mathematics instruction.	1	2	3	4	5
4. Merge materials and equipment into a total program.	1	2	3	4	5
5. Evaluate progress in mathematics in terms of instructional goals.	1	2	3	4	5

APPENDIX B

RESULTS OF TEACHER QUESTIONNAIRE

SELECTED RESPONSIBILITIES OF SPECIAL EDUCATION TEACHERS: RESULTS FROM TWENTY-FIVE RESPONDENTS

1- I am satisfied with this
2- This needs some improvement
3- This needs much improvement
4- This is nonexistent, or nearly so.

Statement	Response	Number of Respondents	Percentage of Respondents
1. Pattern of organizing within the classroom for mathematics instruction	1	5	20%
	2	5	20%
	3	15	60%
	4	0	0%
2. Materials available for use in the program	1	4	16%
	2	6	24%
	3	15	60%
	4	0	0%
3. Workbooks and other supplementary materials available, as manipulatives	1	0	0%
	2	4	16%
	3	7	28%
	4	14	56%
4. Teacher knowledge of how to teach mathematics effectively	1	7	28%
	2	13	52%
	3	5	20%
	4	0	0%
5. Time available for mathematics instruction	1	25	100%
	2	0	0%
	3	0	0%
	4	0	0%
6. Extent to which pupils enjoy mathematics	1	4	16%
	2	19	76%
	3	2	8%
	4	0	0%

7. Extent to which staff has input on program choice	1	1	4%
	2	5	20%
	3	19	76%
	4	0	0%
8. Extent to which program is related to specific needs of all the individuals within program	1	1	4%
	2	24	96%
	3	0	0%
	4	0	0%
9. Extent to which you are familiar with goals of program	1	3	12%
	2	17	68%
	3	5	20%
	4	0	0%
10. Overall evaluation of present mathematics program. The present mathematics program addresses visual perceptual deficits of handicapped pupils	1	2	8%
	2	4	16%
	3	19	76%
	4	0	0%

1- Almost always
2- Most of the time
3- Sometimes
4- Seldom or never
5- Undecided

As a Special Education teacher, I

Statement	Response	Number of Respondents	Percentage of Respondents
1. Aim mathematics instruction toward achievement of specific goals	1	5	20%
	2	7	28%
	3	13	52%
	4	0	0%
	5	0	0%
2. Adapt mathematics instruction to the individual levels, abilities, and needs of all pupils	1	5	20%
	2	15	60%
	3	5	20%
	4	0	0%
	5	0	0%
3. Use diagnostic-prescriptive approach to mathematics instruction	1	4	16%
	2	7	28%
	3	14	56%
	4	0	0%
	5	0	0%
4. Merge materials and equipment into a total program	1	4	16%
	2	7	28%
	3	14	56%
	4	0	0%
	5	0	0%
5. Evaluate progress in mathematics in terms of instructional goals.	1	7	28%
	2	5	20%
	3	13	52%
	4	0	0%
	5	0	0%

APPENDIX C

PRE AND POSTTEST SCORES FOR OBJECTIVE A
WITH
TEST MEAN RESULTS

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	60%	85%	+ 25%
2	15%	30%	+ 15%
3	60%	85%	+ 25%
4	20%	35%	+ 15%
5	55%	80%	+ 25%
6	25%	40%	+ 15%
7	30%	40%	+ 10%
8	40%	60%	+ 20%
9	40%	60%	+ 20%
10	55%	75%	+ 20%
11	20%	40%	+ 20%
12	35%	55%	+ 20%
13	50%	70%	+ 20%
14	25%	40%	+ 15%
15	50%	70%	+ 20%
16	35%	55%	+ 20%
17	55%	75%	+ 20%
18	15%	25%	+ 10%
19	60%	85%	+ 25%
20	15%	35%	+ 20%

Pretest Mean: 38%
Posttest Mean: 57%
Mean Gain: 19%

APPENDIX D

PRE AND POSTTEST SCORES FOR OBJECTIVES B THROUGH G
WITH
TEST MEAN RESULTS

OBJECTIVE B: NUMBERS 0 TO 10

Task: Pupil is able to successfully write numerals and count elements 0 to ten as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.
Scores are reported as percents.

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	60%	90%	+ 30%
2	20%	50%	+ 30%
3	40%	80%	+ 40%
4	30%	60%	+ 30%
5	40%	80%	+ 40%
6	30%	60%	+ 30%
7	30%	70%	+ 40%
8	40%	70%	+ 30%
9	40%	70%	+ 30%
10	30%	50%	+ 20%
11	40%	70%	+ 30%
12	30%	70%	+ 40%
13	40%	70%	+ 30%
14	30%	70%	+ 40%
15	40%	70%	+ 30%
16	40%	80%	+ 40%
17	40%	70%	+ 30%
18	20%	50%	+ 30%
19	50%	90%	+ 40%
20	20%	40%	+ 20%

Pretest Mean: 36%
Posttest Mean: 68%
Mean Gain: 32%

OBJECTIVE C: ADDITION--SUMS TO 10

Task: Pupil can successfully solve ten problems that involve the addition of quantities of money sums to 10 cents, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.
Scores are reported as percents.

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	50%	80%	+ 30%
2	20%	40%	+ 20%
3	40%	80%	+ 40%
4	10%	40%	+ 30%
5	40%	60%	+ 20%
6	20%	50%	+ 30%
7	30%	70%	+ 40%
8	50%	70%	+ 20%
9	40%	80%	+ 40%
10	20%	30%	+ 10%
11	30%	50%	+ 20%
12	30%	80%	+ 50%
13	40%	70%	+ 30%
14	20%	60%	+ 40%
15	30%	60%	+ 30%
16	30%	80%	+ 50%
17	40%	60%	+ 20%
18	20%	50%	+ 30%
19	60%	90%	+ 30%
20	20%	30%	+ 10%

Pretest Mean: 32%
Posttest Mean: 62%
Mean Gain: 30%

OBJECTIVE D: SUBTRACTION--SUMS TO 10

Task: Pupil can successfully solve ten problems that involve the subtraction of quantities of money, sums to 10 cents, as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.
Scores are reported as percents.

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	30%	70%	+ 40%
2	20%	40%	+ 20%
3	30%	70%	+ 40%
4	10%	40%	+ 30%
5	30%	50%	+ 20%
6	20%	40%	+ 20%
7	30%	70%	+ 40%
8	40%	70%	+ 30%
9	40%	90%	+ 50%
10	10%	50%	+ 40%
11	30%	60%	+ 30%
12	30%	80%	+ 50%
13	40%	80%	+ 40%
14	20%	60%	+ 40%
15	20%	60%	+ 40%
16	10%	70%	+ 60%
17	30%	70%	+ 40%
18	20%	30%	+ 10%
19	40%	80%	+ 40%
20	20%	30%	+ 10%

Pretest Mean: 26%
Posttest Mean: 61%
Mean Gain: 35%

OBJECTIVE E: PLACE VALUE

Task: Pupil can successfully count by 2's, 5's, and 10's up to 99 objects and choose the proper standard numeral for the number as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative activity.
Scores are reported as percents.

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	20%	60%	+ 40%
2	10%	40%	+ 30%
3	30%	70%	+ 40%
4	10%	40%	+ 30%
5	30%	50%	+ 20%
6	20%	40%	+ 20%
7	10%	50%	+ 40%
8	20%	50%	+ 30%
9	20%	70%	+ 50%
10	10%	60%	+ 50%
11	10%	60%	+ 50%
12	10%	70%	+ 60%
13	20%	70%	+ 50%
14	20%	70%	+ 50%
15	10%	30%	+ 20%
16	10%	30%	+ 20%
17	20%	70%	+ 50%
18	10%	20%	+ 10%
19	30%	70%	+ 40%
20	20%	60%	+ 40%

Pretest Mean: 15%
Posttest Mean: 46%
Mean Gain: 31%

OBJECTIVE F: TIME

Task: Pupil will successfully (requiring ten attempts) to tell time at the hour and to the half hour as measured by attaining a score of at least 70% on an oral, instructor-directed manipulative activity. Scores are reported as percents.

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	0%	30%	+ 30%
2	0%	20%	+ 20%
3	0%	50%	+ 50%
4	0%	20%	+ 20%
5	0%	40%	+ 40%
6	0%	20%	+ 20%
7	0%	10%	+ 10%
8	10%	70%	+ 60%
9	0%	70%	+ 70%
10	0%	10%	+ 10%
11	0%	10%	+ 10%
12	0%	60%	+ 60%
13	0%	70%	+ 70%
14	10%	70%	+ 60%
15	0%	20%	+ 20%
16	10%	20%	+ 10%
17	10%	60%	+ 50%
18	0%	10%	+ 10%
19	20%	70%	+ 50%
20	10%	70%	+ 60%

Pretest Mean: 2%
Posttest Mean: 40%
Mean Gain: 38%

OBJECTIVE G: MONEY

Task: Pupil will be successfully able to form a collection of pennies, nickels, and dimes that has a given value up to 99 cents as measured by attaining a score of at least 70% on an oral, instructor-directed, manipulative acitivity. Scores are reported as percents.

Subject	Pretest	Posttest	Gain (+) or Loss (-)
1	10%	60%	+ 50%
2	20%	70%	+ 50%
3	10%	70%	+ 60%
4	0%	20%	+ 20%
5	20%	80%	+ 60%
6	0%	20%	+ 20%
7	10%	20%	+ 10%
8	20%	80%	+ 60%
9	10%	70%	+ 60%
10	10%	20%	+ 10%
11	20%	70%	+ 50%
12	30%	70%	+ 40%
13	0%	70%	+ 70%
14	30%	80%	+ 50%
15	0%	30%	+ 30%
16	20%	30%	+ 10%
17	30%	80%	+ 50%
18	10%	20%	+ 10%
19	30%	70%	+ 40%
20	30%	60%	+ 30%

Pretest Mean: 16%
Posttest Mean: 51%
Mean Gain: 35%

APPENDIX E

WEEKLY LOG

WEEKLY LOG

	STRENGTH (S)	WEAKNESS (W)
Pretest	_____	_____
Equivalent Sets	_____	_____
Sets of 1 and 2	_____	_____
Sets of 3 and 4	_____	_____
Sets of 5 and 6	_____	_____
Sets of 7 and 8	_____	_____
Sets of 9 and 10	_____	_____
Zero and Pennies	_____	_____
Posttest	_____	_____

Comments:

Pretest	_____	_____
Joining Sets	_____	_____
Adding sums to Five	_____	_____
Adding sums to Ten	_____	_____
Commutativity	_____	_____
Less than, Greater than	_____	_____
Order on the number line	_____	_____
Ordinal Numbers	_____	_____
Addition Equations	_____	_____
Posttest	_____	_____

Comments:

	STRENGTH (S)	WEAKNESS (S)
Pretest	_____	_____
Separating Sets	_____	_____
Subtracting from Five	_____	_____
Subtracting from Ten	_____	_____
Subtracting with Money	_____	_____
Subtraction Equations	_____	_____
Problem Solving	_____	_____
Posttest	_____	_____

Comments:

Pretest	_____	_____
Recognizing Sets of tens	_____	_____
Ordering Numbers	_____	_____
Numerals tens to 50	_____	_____
Tens to 90	_____	_____
Table Form/standard Form	_____	_____
Order of Numbers to 100	_____	_____
Comparing numbers	_____	_____
Counting by 10's	_____	_____
Counting by 5's and 2's	_____	_____
Posttest	_____	_____

Comments:

	STRENGTH (S)	WEAKNESS (W)
Pretest	_____	_____
Can discriminate among coins	_____	_____
Can pay for items and make change	_____	_____
Can write money amounts	_____	_____
Can read clock times	_____	_____
Can name correct hour	_____	_____
Can fathom various ways to tell time	_____	_____
Can grasp temporal expressions	_____	_____
Posttest	_____	_____

Comments:

Pupils has acceptable retention skills	_____	_____
Pupil is able to employ logical thinking; does not require specific training	_____	_____
Pupil does not exhibit auditory/visual perceptual deficiency (s) which inhibits accuracy in interpreting what is presented	_____	_____
No sign of misperception of words or parts of words or numerals	_____	_____

Comments:

	STRENGTH (S)	WEAKNESS (W)
Pupil exhibited an adequate grasp of group activities (games) during the implementation period	_____	_____
Works well in small group situations	_____	_____
War	_____	_____
Go Fish	_____	_____
Concentration	_____	_____
Tic Tac Toe	_____	_____
Piggy Bank	_____	_____

Comments:

APPENDIX F

LETTER OF PERMISSION
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July 27, 1988

Mr. James Patrick Burke
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